

METHOD FOR REMOVING FINE FOREIGN MATTERS,
AND ROLLING BEARING USING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a bearing excellent in noise, vibration and durability in rotational support members of household electric appliances such as hard disk drives, videos, OA equipment, air conditioners and cleaners, and vehicles.

2. Description of the Related Art

[0002] A rolling bearing consists of, for instance, an inner ring and an outer ring each of which has a raceway surface, a plurality of rolling elements, and a retainer. The rolling elements are rotatably disposed between the raceway surfaces of the inner and outer rings. Additionally, each rolling element is rotatably retained with the retainer at a given spacing therebetween. When the rolling bearing is in use, the rolling elements rotate and revolve around the inner ring, and the retainer rotates around the inner ring at the same speed as the revolving speed of the rolling elements. Along with the rotation of the rolling elements, the inner ring and the outer ring relatively rotate in a free manner.

[0003] Therefore, in case foreign matters are adhered to a contact surface between the rolling elements and the raceway surfaces of inner and outer rings, between the rolling elements and the retainer, between the raceway surfaces of inner and outer rings and the retainer and so forth, noise is generated. In addition, surface roughening and brinellings may be formed on the raceway surfaces or the rolling elements thereby negatively influencing in sound, vibration, rotational precision, durability and reliability. Thus, a barrel polishing process is

provided after each cutting process, heat-treating process and grinding process of rolling bearing parts (outer ring, inner ring, rolling elements and retainer) in order to remove residual fine foreign matters generated in the processes, including metal powder like a metal chips and falling pieces of bearing components.

[0004] However, a grinding medium for use in removing residual fine foreign matters in the barrel polishing process contains a material of high hardness such as sintered fine particles of silicon, alumina and so forth as main components. Thus, the surface of the rolling bearing parts is severely damaged when the number of rotations and vibration frequency of a barrel finishing machine is increased likely causing a damage. Moreover, since the grinding medium is hardly elastically deformed, it will be effortful for suitably accommodating the medium to a surface of parts which operate to remove residual fine foreign matters thereby presenting difficulties to remove the foreign matters adhered to the surface thereof. A problem is also found in that the grinding medium itself stays on a product surface as residual fine foreign matter.

[0005] Therefore, it has been inevitable to take a high precision water-washing process as a final process of manufacturing parts so as to completely remove residual fine foreign matters. In the high precision water-washing process, rolling bearing parts are dipped in water and applied with ultrasonic waves while being swung. If necessary, each part is also directly showered or rinsed with a water jet to improve cleanliness. However, even by the high precision water-washing process, fine foreign matters at a surface of parts is not completely removed and often stays on the surface. A problem is also found in that the effects of foreign matters or dusts are generally more serious in a miniature bearing than other types of bearings.

SUMMARY OF THE INVENTION

[0006] Accordingly, it is an object of the present invention to infallibly remove residual fine foreign matters when manufacturing bearing parts. It is also an object of the invention to prevent surface roughening and brinellings on a raceway surface and rolling elements caused by residual fine foreign matters on the surface of parts, and to prevent sound, vibration, rotational accuracy, durability and reliability from declining thereby.

[0007] In order to solve the above problems, a method for removing fine foreign matters according to a first aspect of the invention includes a process of removing residual fine foreign matters with a grinding medium having lower hardness than the residual fine foreign matters prior to a high precision water-washing process in manufacturing bearing parts.

[0008] According to the invention, since the medium has lower hardness than the residual fine foreign matters, damages to a surface of bearing parts may be inhibited even when contact pressure of the medium against the bearing parts is increased to improve the removal of the residual fine foreign matter.

Additionally, as the hardness of the medium is low, the medium may easily accommodate to a surface of bearing parts so that the medium can more effectively remove the adhered residual fine foreign matters.

[0009] Moreover, according to a second aspect of the invention, the grinding medium has various shapes so that the medium collides against fine foreign matters adhered to bearing parts in various ways. Thus, residual fine foreign matters may be effectively removed.

[0010] Furthermore, according to a third aspect of the invention, the grinding medium is made from a corn-cob as a raw material. Since a corn-cob

has lower hardness than the residual foreign matters adhered to a surface of bearing parts, damage to the surface of bearing parts may be inhibited. Additionally, a corn-cob is likely to fit to the surface of bearing parts so as to work for more effective removal of the adhered residual fine foreign matters. And, various shapes of the corn-cob result in more effective removal of residual fine foreign matters.

[0011] Additionally, according to a fourth aspect of the invention, a barrel finishing machine is used in the process of removing residual foreign matters. By the barrel finishing machine, the medium and bearing parts are contacted to each other in such a manner as to scrape off hard residual fine foreign matters adhered to bearing parts. In addition, residual fine foreign matters are stuck to a soft surface of the medium, so that the foreign matters may be taken into the medium and removed from the bearing parts.

[0012] And, according to a fifth aspect of the invention, a rolling bearing is combined with the parts from which residual fine foreign matters are removed through the methods of first to fourth aspects of the invention. In the invention residual fine foreign matters are removed from each part of the rolling bearing, whereby noise, surface roughening and brinellings on a raceway surface and rolling elements, and negative effects on sound, vibration, rotational accuracy, durability and reliability caused by the foreign matters during use are minimized.

BRIEF DESCRIPTION OF THE DRAWING

[0013] FIG. 1 is a flow chart, showing a manufacturing process of each component of a rolling bearing according to an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0014] A preferred embodiment of the present invention will be explained with reference to the attached drawing.

[0015] In the preferred embodiment of the present invention, a removal process 4 of residual fine foreign matter with a grinding medium having lower hardness than residual fine foreign matters, is taken prior to a high precision water-washing process 5 in the manufacturing process of each component parts of a rolling bearing shown in Fig. 1. Accordingly, residual fine foreign matters generated in a cutting process 1, a heat-treating process 2 and a grinding process 3 are removed, including metal powder like metal chip and falling pieces of the bearing components.

[0016] The grinding medium is made from a corn-cob as a raw material, and the medium is dried and then crushed into medium pieces. Such a medium made from a corn-cob as a raw material (called as "cob medium" hereinafter) has lower hardness than residual foreign matters adhered to a surface of bearing parts, whereby damages to a surface of rolling bearing parts are minimized when removing the foreign matters by the barrel finishing process. Moreover, a cob medium is likely to fit to a surface of bearing parts so as to work for more effective removal of the adhered residual fine foreign matters. Furthermore, various shapes of the cob medium result in more effective removal of residual fine foreign matters. And, as a substitute material for a cob medium, wooden chips, nylon chips, and so forth may be used.

[0017] Moreover, in the removal process 4 of residual fine foreign matters, a barrel finishing machine is used. A cob medium and rolling bearing parts are

contacted to each other by the barrel finishing machine in such a manner as to scrape off hard residual fine foreign matters adhered to the rolling bearing parts. And, residual fine foreign matters are stuck to a soft surface of the cob medium and is taken into the cob medium and then removed from the bearing parts. Furthermore, a surface of rolling bearing parts may be mirror-finished by the cob medium at the same time with the removal of residual fine foreign matter.

[0018] As the barrel finishing machine, a centrifugal barrel machine, a vibrating tumbler and so forth may be used. Furthermore, a size (mesh) in which crushed pieces of a cob medium are classified in a longitudinal direction, is appropriately selected from 0.2 to 0.5 mm, 0.5 to 1.0 mm, 1.5 to 1.7 mm, 1.7 to 2.0 mm, 2.0 to 2.4 mm, 2.4 to 3.2 mm, 3.2 to 4.0 mm and so forth, based on the shape, size and so forth of rolling bearing parts.

[0019] In the removal process 4 of residual fine foreign matters, rolling bearing parts and a cob medium are filled into a barrel cylindrical tank of a barrel finishing machine at about 20% to 80% of an entire volume of the barrel cylindrical tank. The bearing parts and the cob medium are then polished for approximately 10 minutes to two hours.

[0020] In the preferred embodiment of the present invention, deposits (mainly, cob medium) are removed by washing with water or ultrasonic waves in the precision water-washing process 5 after the removal process 4 shown in FIG. 1. Rolling bearing parts from which residual fine foreign matter is removed, may be obtained after a drying process 6 with blowing air.

[0021] A rolling bearing is manufactured by combining the parts from which residual fine foreign matter is removed by the method described above. Accordingly, noise, surface roughening and brinellings on a raceway surface and rolling elements, and negative effects on sound, vibration, rotational precision,

durability and reliability caused by residual fine foreign matter during use are minimized.

[0022] The amounts of residual fine foreign matters adhered to rolling bearing parts are compared between the manufacturing process of rolling bearing parts including the removal process 4 (preferred embodiment of the invention) and the manufacturing process without the removal process 4 (conventional art). The comparison is based on the following method.

[0023] First, five evaluation test pieces are inserted to a beaker, and a clean solvent (substitute Flon : AK225) is poured therein. Subsequently, ultrasonic waves are applied to the beaker for three minutes, and residual fine foreign matters are removed from the evaluation test pieces into the solvent. Then, the number of residual fine foreign matters of 1 μm or more in the solvent is measured by a LPC (Liquid Particle Counter).

[0024] The LPC has a semiconductor laser as a light source. The LPC detects a decrease in the quantity of light at a photo detector due to light scattering and slight diffraction caused by residual fine foreign matters, by irradiating parallel beams to the solvent, and calculates the number of residual fine foreign matters having a setting diameter or larger. The measuring range (μm) may be selected from 0.5 to 1.0, 1.0 to 2.0, 2.0 to 5.0, 5.0 to 10, 10 and higher, and so forth. The value in which the number of particles measured by the LPC is divided by the number of testing pieces (five), is assumed to be the number of adhered residual fine foreign matters per testing piece.

[0025] The amount of residual fine foreign matters was compared between the preferred embodiment of the invention and the conventional art by the method mentioned above. According to the result, it was confirmed that the quantity of residual fine foreign matters of the testing pieces obtained by the

preferred embodiment of the invention is 60% less than that of the testing pieces obtained by the conventional process.

[0026] As a result, the present invention has the following effects. First, according to the method of removing fine foreign matters according to the first aspect of the invention, residual fine foreign matters can be infallibly removed when manufacturing the rolling bearing parts. Moreover, a rolling bearing may be provided which prevents surface roughening and brinellings on a raceway surface and rolling elements due to residual fine foreign matters on the surface thereof, and prevents sound, vibration, rotational accuracy, durability and reliability from declining thereby. The rolling bearing is suitable for rotational support members of household electric appliances such as hard disk drives, videos, OA equipment, air conditioners and cleaners and vehicles and is excellent in noise, vibration and durability.

[0027] Moreover, according to the second aspect of the invention, residual fine foreign matters may be effectively removed, and residual fine foreign matters can be infallibly removed when manufacturing bearing parts.

According to the third aspect of the invention, damages to a surface of bearing parts may be minimized, and residual fine foreign matters may be effectively removed. Thus, residual fine foreign matters can be infallibly removed when manufacturing bearing parts.

[0028] According to the fourth aspect of the invention, a medium and bearing parts contact to each other in such a manner as to scrape off hard residual fine foreign matters adhered to bearing parts. Fine foreign matters are stuck to a soft surface of the medium, and is taken into the medium and then removed from the bearing parts. Thus, residual fine foreign matters can be infallibly removed when manufacturing bearing parts.

[0029] Furthermore, the rolling bearing according to the fifth aspect of the invention prevents surface roughening and brinellings on a raceway surface and rolling elements due to residual fine foreign matters on a surface of parts, and prevents sound, vibration, rotational precision, durability and reliability from declining thereby. The rolling bearing is suitable for rotational support members of household electric appliances such as hard disk drives, videos, OA equipment, air conditioners and cleaners and vehicles, and is excellent in noise, vibration and durability.